

California Energy Commission
Alternative and Renewable Fuel and Vehicle
Technology Program
FINAL PROJECT REPORT

ONTARIO HYDROGEN STATION

Prepared for: California Energy Commission

Prepared by: Ontario CNG Station, Inc.

California Energy Commission

Gavin Newsom, Governor

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Primary Author(s):

Atabak Youssefzadeh

Ontario CNG Station, Inc.
1850 E Holt Blvd
Ontario, CA 91761

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Prepared for:

California Energy Commission

Phil Cazel
Chris Jenks
Agreement Managers

Jacqueline Gaskill
Office Manager
Zero-Emission Vehicle and Infrastructure Office

Kevin Barker
Deputy Director
Fuels and Transportation Division

Drew Bohan
Executive Director

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ACKNOWLEDGEMENTS

The valuable contributions of many visionaries made the construction of the hydrogen station at 1850 East Holt Boulevard, Ontario (San Bernardino County) possible. The Ontario CNG team would like to take this opportunity to thank each and every one of the organizations and individuals for their great contributions.

First and foremost, we would like to thank the California Energy Commission and Southern California Air Quality Management District for making this project possible.

We would also like to thank the following individuals: Jean Baronas, Chris Jenks, John Butler, Patricia Kwon and Lisa Mirisola for all their help and foresight.

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We also thank StratosFuel, Inc., Hydrogenics Corporation, Allsup Corporation, Rimma Construction, Inc., Keith Sharpe, and Raymond Jones for their valuable contributions to the design, engineering, and construction of the Ontario hydrogen refueling station.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007), created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). The statute authorizes the California Energy Commission to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) re-authorizes the ARFVTP through January 1, 2024, and specifies that the Energy Commission allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The ARFVTP has an annual budget of approximately \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and non-road vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

The Energy Commission issued Program Opportunity Notice (PON)-13-607 to provide funding opportunities under the ARFVTP for hydrogen refueling stations. To be eligible for funding under PON-13-607, the projects must also be consistent with the Energy Commission's ARFVTP Investment Plan, updated annually. In response to PON-13-607, the recipient submitted an application which was proposed for funding in the Energy Commission's notice of proposed awards May 1, 2014 and the agreement was executed as ARV-14-009 on August 6, 2014.

ABSTRACT

Ontario CNG Station, Inc. designed, engineered, permitted, constructed, and commissioned a 100 percent renewable hydrogen refueling station located at 1850 East Holt Boulevard, Ontario (San Bernardino County). The Ontario CNG Station generates up to 65 kilograms of 100 percent renewable hydrogen using an on-site electrolyzer with renewable electricity as a feedstock. The station also receives 100 percent renewable hydrogen delivered from a nearby source to achieve the 100 kilogram per day capacity in accordance with the Energy Commission agreement. Ontario CNG Station, Inc. owns the entire site including a convenience store, car wash, bio-fuel dispenser, bio-diesel dispenser, two electric chargers including a fast charger, compressed natural gas dispensers, and conventional petroleum fuels. Ontario CNG Station plans to provide hydrogen refueling for the foreseeable future as a part of their existing alternative fuel options. Ontario CNG installed the containerized hydrogen equipment as a unique two-story stacked configuration for efficacy of space and ease of plumbing and mechanical installation. A concrete reinforced block enclosure surrounds the on-site hydrogen storage tubes. The hydrogen dispenser is on a fueling island under a canopy featuring compressed natural gas.

Keywords: California Energy Commission, Ontario CNG Station, Inc., fuel cell electric vehicles, Ontario, hydrogen infrastructure, hydrogen refueling station.

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EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles (FCEVs) and hydrogen refueling stations are expected to play key roles in California as the state transitions to lower-carbon and zero-emission vehicle technologies for light-duty passenger vehicles, transit buses, and truck transport fleets. Numerous government regulations and policy actions identify FCEVs as a vehicle technology that will be available to meet the California Air Resources Board's zero-emission vehicle regulation and the specific actions to bring FCEVs to California markets specified in the Governor's Zero Emission Vehicle Action Plan.

The Ontario Hydrogen Station is a unique addition to the publicly accessible hydrogen network serving the community surrounding Ontario. The grant from the California Energy Commission enabled the station owner to design and construct a renewable hydrogen station with one dispenser and two nozzles that provide 700 bar and 350 bar fueling. The California Energy Commission contributed \$1,750,000 of the over \$2,510,000 total cost to design, engineer, permit, and construct the Ontario station operational.

The main objective of constructing the Ontario hydrogen station is to provide additional necessary hydrogen refueling infrastructure to the community, reduce dependency on foreign and fossil fuel, and to reduce greenhouse gases and particulates in the environment including carbon dioxide, oxides of nitrogen, carbon monoxide, and volatile organic compounds.

The design team composed of Atabak Youssefzadeh (Architect), Keith Sharpe (Project Engineer) and Ann Murry (Hydrogenics Corporation) developed the site configuration and design, and performed the detailed engineering design.

The team began construction on July 20, 2015, which they substantially completed October 29, 2015. The construction phase finished on schedule but final utility connections were delayed by an ongoing \$55 million public works project to create an underpass for Vineyard Avenue, the North Vineyard Grade Separation Project, that included a rail road bridge and undergrounding of all the utilities and infrastructure at the intersection of Holt Boulevard and Vineyard Avenue, surrounding two sides of the station.

The North Vineyard Grade Separation Project helped cause the station to open later than originally planned and miss agreement deadlines. This caused the initial grant award of \$2,125,000 to be reduced to \$1,750,000.

The process of making the station operational was completed on November 9, 2017, and the station became open for retail sales on March 29, 2018. The Ontario hydrogen station can dispense 100 kilograms of 100 percent renewable hydrogen per day.

CHAPTER 1:

Station Design and Construction

There were many steps required to bring the Ontario hydrogen refueling station to completion. This chapter highlights the most critical items, provides detail on each, and states the timing required for each step of the project.

Site Acquisition – Design, Permitting, and Construction (August 2008 – August 2017)

Ontario CNG Station Inc., purchased the property in August 2008 to provide alternative transportation fuels such as hydrogen, compressed natural gas, electric charging, and biofuels for drivers in and around Ontario. The shareholders of Ontario CNG Station, Inc. voted to design and construct a hydrogen station on the property in January 2014 and submitted an application under PON-13-607 on February 14, 2014.

The Notice of Proposed Awards listed the \$2,125,000 grant for the Ontario Hydrogen Station on May 1, 2014. The Energy Commission approved the agreement at a business meeting on July 22, 2014. The agreement was executed on August 6, 2014.

The City of Ontario's planning department recommended to approve the station design on November 1, 2014. The Ontario hydrogen station was challenging to design because the traffic circulation within the station is very limited and the site is narrow in the back, which impacts the placement of hydrogen refueling station equipment. The two hydrogen equipment containers use a custom two-story stacked configuration and simplified plumbing and mechanical interconnections between various components to help efficiently use limited site space.

Keith Sharp performed the engineering design and his engineering firm, Allsup Corporation, provided ongoing construction administration support. The two-story stacked hydrogen equipment container design decreased the footprint of the station and required unique engineering approaches to the layout of the station components. The team installed all the heavy compressors in the first floor container and the lighter equipment components in the second floor container. The team placed equipment that needed to be open to the air in an area where designed openings allow for ease of maintenance and air circulation to prevent hydrogen from being trapped in a closed area causing a safety risk. The National Fire Protection Association's (NFPA) hydrogen technologies code guided the placement of the hydrogen storage cylinders which are required to be contained behind a large block wall and meet safety related set-back requirements.

All areas with hydrogen equipment are equipped with sensors that detect leaks and would shut down the electrolyzer's hydrogen production and all refueling operations in

the event of system failure. Figure 1 shows the upper and lower units, in the two story equipment configuration before the construction team added the finishing touches.

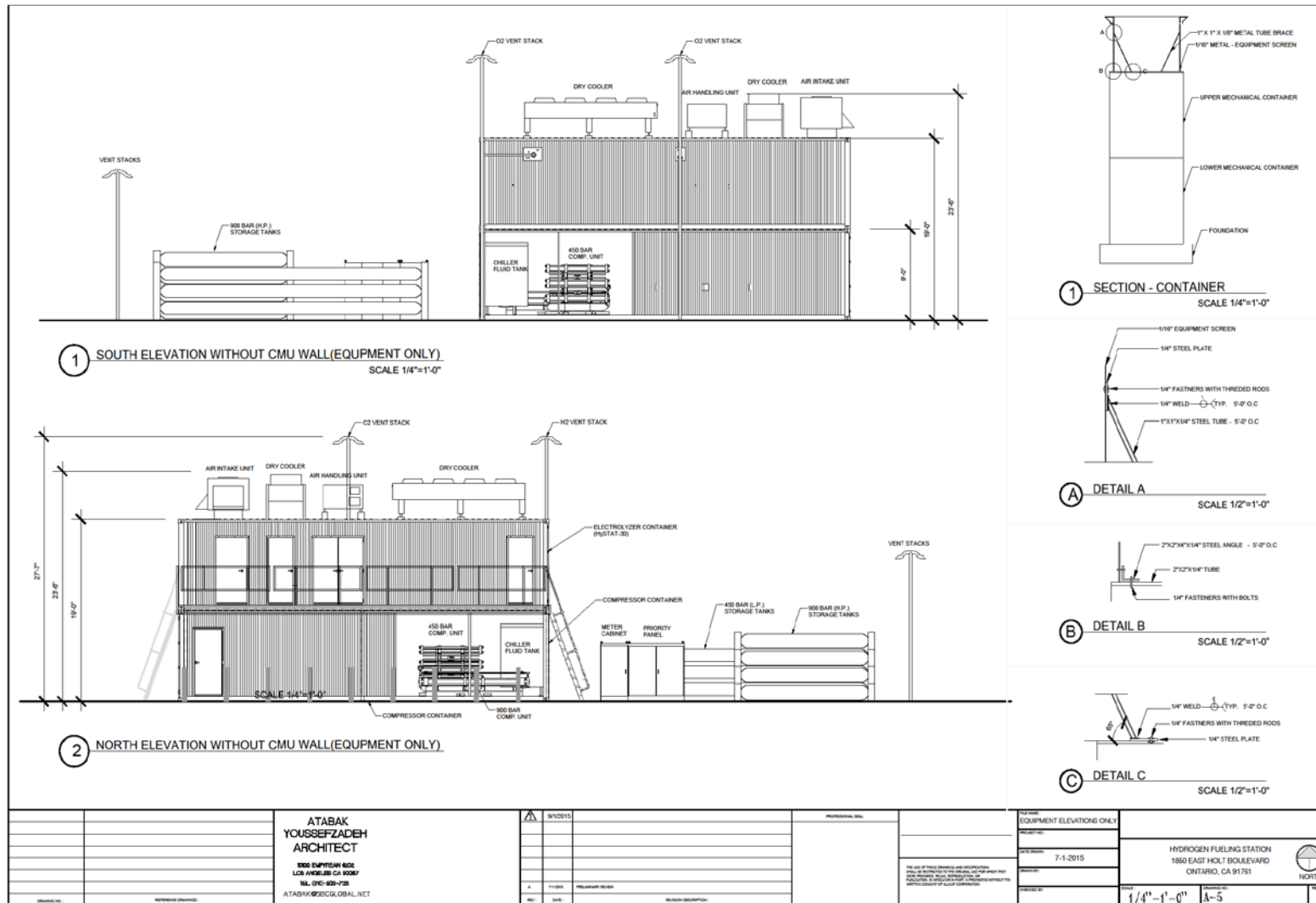
Figure 1: Two Story Equipment Configuration



Source: Energy Commission Staff

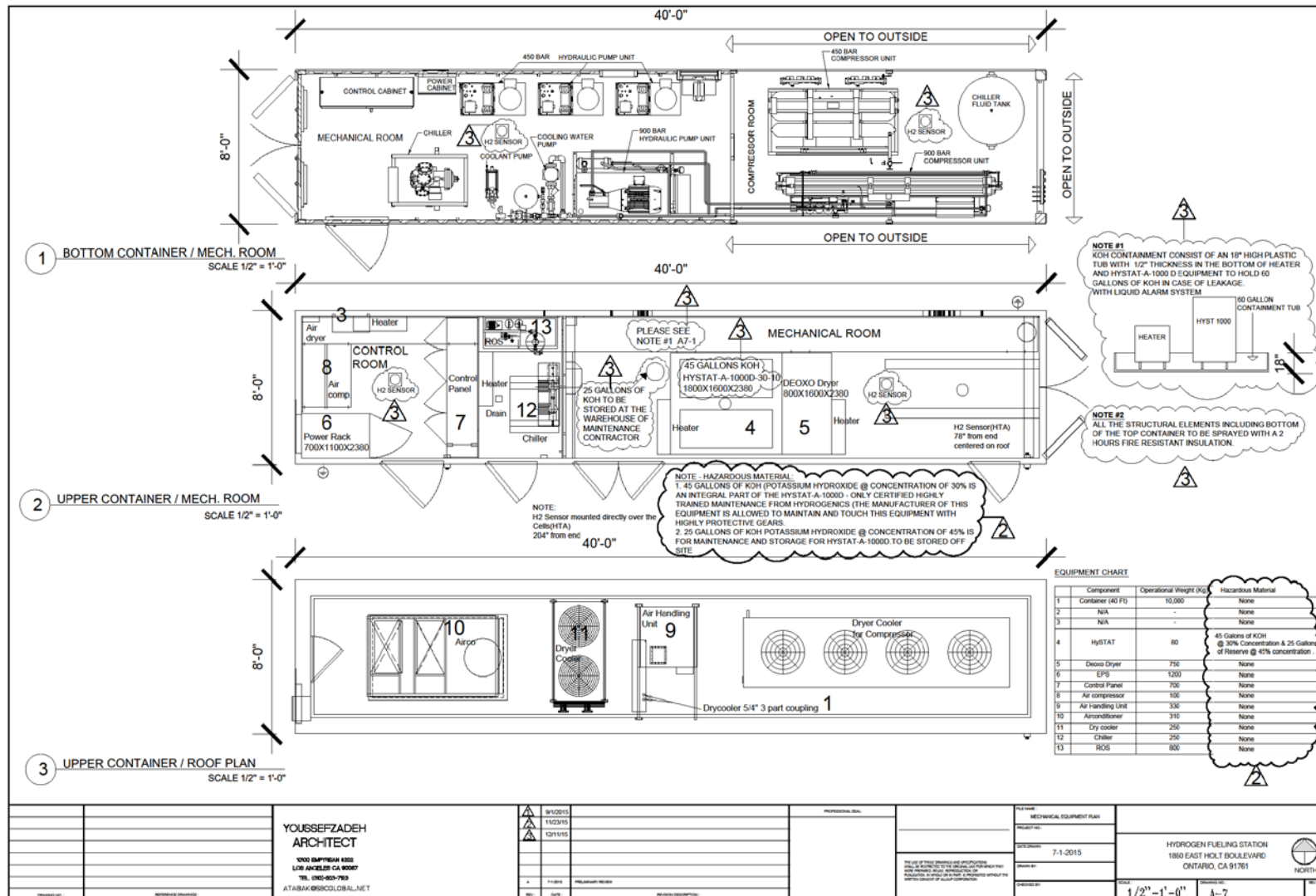
Figures 2 and 3 are the construction drawings of the exterior of the stacked equipment containers and the equipment layout inside the two containers.

Figure 2: Stacked Equipment Container Plans



Source: Ontario CNG Station, Inc.

Figure 3: Equipment Layout Inside the two Containers



Source: Ontario CNG Station, Inc.

In October 2014, Ontario CNG Station, Inc. met with the City of Ontario Planning Department and the Fire Department, which led to the city waiving the need for a conditional use permit. This decision saved four months in the permitting process. The City of Ontario granted entitlements on September 25, 2014, just one month after the application was submitted. The City of Ontario did not require a public hearing. Fezikas and Associates, from Irvine, California, handled the building, mechanical, electrical, plumbing, and structural drawings plan check.

In November 2014, the City of Ontario engineers and Southern California Edison met to resolve the location of the new electrical transformer and gear box for the increased electrical demand from the hydrogen station equipment.

Ontario CNG Station, Inc. submitted detailed plans to the City of Ontario Building Department in early January 2015 for review and approval to build was granted on October 2, 2015.

Once all the equipment was placed on the site plan, the team decided to procure the equipment. The team ordered the equipment from Hydrogenics as soon as the approval was obtained from the station owners and the City of Ontario. Hydrogenics shipped the equipment from Mississauga, Ontario, Canada, after it was inspected for safety and completeness.

On July 20, 2015, the team began the station construction and finished on schedule. The City of Ontario building inspector signed off on the final building, electrical, plumbing, and mechanical inspections on October 29, 2015. Energy Commission staff conducted a site visit on October 30, 2015, confirming that all equipment was installed at the site. A \$55 million public works project to create a rail road underpass for Vineyard Avenue, known as the North Vineyard Grade Separation Project, delayed the final utility connections. Figure 4 shows the underpass site under construction.

A partnership between the City of Ontario, the County of San Bernardino, the San Bernardino Associated Governments, and Union Pacific Railroad sponsored the grade separation project. The project included a railroad bridge and relocation of all the utilities and infrastructure at the intersection of Holt Boulevard and Vineyard Avenue. The City of Ontario's general contractor and the principal engineer assured Ontario CNG Station, Inc. that the railroad underpass project would not interfere with the proposed timeline of the Ontario Hydrogen Station project at the time of application. Figure 4 and Figure 5 show the underpass construction and the hydrogen station site construction on June 30, 2015.

Figure 4: Underpass Construction 6/30/2015



Source: Ontario CNG Station, Inc.

Figure 5: Driveway of Gas Station 6/30/2015



Source: Ontario CNG Station, Inc.

Ontario CNG Station, Inc. received the equipment after the concrete equipment pads had fully cured so the weight of the heavy equipment would not damage the concrete. Figure 6 shows the lower section placed next to the pad awaiting final placement.

Figure 6: Equipment Arrival at Station



Source: Ontario CNG Station, Inc.

After the outreach performed by the Governor's Office of Business and Economic Development (GO-Biz) and Energy Commission staff, Southern California Edison informed Energy Commission staff the electrical service upgrade for the Ontario Hydrogen Station would be completed on March 15, 2016; however, Southern California Edison did not complete the power connection until April 11, 2016.

Even though the City of Ontario building inspector signed off on the final building, electrical, plumbing, and mechanical inspections on October 29, 2015, the City of Ontario's supervising building inspector contacted Ontario CNG Station, Inc. on April 7, 2016, to inform them that a new law came into effect in January 2016, which requires a field evaluation of "unlisted" electrical equipment. This new electrical field evaluation requires third party certification before the city building department could issue an operating permit, which added approximately \$25,000 to the cost.

Figure 7 shows the original fueling station power lines temporarily suspended during construction prior to placement underground and being connected to the new service.

Figure 7: Temporary Placement of Power Lines



Source: Ontario CNG Station, Inc.

Ontario CNG Station, Inc. completed the third-party certification process on October 13, 2016. On October 16, 2016, the City of Ontario inspector informed Ontario CNG Station, Inc. that another round of changes were needed for the station equipment enclosures, including providing more clearance for a previously installed electrical panel door and the relocation of a tree. On August 24, 2017, the City of Ontario Building Department signed off on all sections of the building permit package.

The facility is a modern addition to the existing gasoline station with adequate lighting installed at the facility to enhance evening fueling under the canopy. Ontario CNG Station, Inc. also installed cameras for the security of the hydrogen fueling customers and the 24-hour employees inside the store.

Figure 8 shows the completed two-story equipment enclosure.

Figure 8: Completed Equipment Enclosures



Source: Energy Commission Staff

Figure 9 shows the dispenser installed in the fueling lane with the equipment enclosures in the background.

Figure 9: Installed Hydrogen Dispenser



Source: Ontario CNG Station, Inc.

Station Certification

The California Department of Food and Agriculture's Division of Measurement Standards (DMS) enforces California's weights and measures laws and regulations and certifies any device used for metering the sale of commercial items within California. The Ontario hydrogen station achieved certification because the local county weights and measures officer, acting as the registered service agent, dispensed a measured amount of fuel, and confirmed the quantity dispensed is accurately reflected by the dispenser in accordance with examination procedures (EPO NO. 40-A)¹. Ontario CNG Station, Inc. received the dispenser certification on April 27, 2017, allowing the sale of hydrogen to the public.


Making the Station Operational

On November 9, 2017, the Energy Commission declared the station operational after receiving a copy of the signed permit to operate from the City of Ontario and a report of

¹ https://www.cdfa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf.

passing a hydrogen purity test (Figure 10) performed by Smart Chemistry. Ontario CNG Station, Inc. conducted a survey of more than 100 alternative fuel customers that indicated that they would like to have the option of paying cash for fuel in addition to using credit, which is an option not offered at most other hydrogen and compressed natural gas stations in California. This option is now available at the new station in Ontario.

Figure 10: Hydrogen Quality Test




cdfa
CALIFORNIA DEPARTMENT OF
FOOD & AGRICULTURE

Karen Ross
Secretary

California Department of Food and Agriculture
Division of Measurement Standards

Kristin Macey, Division Director

6790 Florin Perkins Road, Suite 100, Sacramento, CA 95828
Phone: (916) 229-3000 Fax: (916) 229-3064



Edmund G. Brown Jr.
Governor

Hydrogen

Sampled By: Andrew Adkins	Date & Time Sampled: 10/17/2017 09:25
Sample #: 17N0177-HYD01	
Brand Name: Hydrogenics	Grade/Service Pressure: H70
Firm: 76	
Address: 1850 Holt Blvd	
City/County/ZipCode: Ontario, San Bernardino 91761	
Reason For Sample: Follow-up	
Case Number: 1700004	
Dispenser ID#: N/A	HQSA ID: 1
Fuel Source: ELE	Volume Purged:
Container: SU4157	
Date & Time Received: 10/19/2017 16:00	
Comments -	
By Sampler:	Station Representative: William Cook
By Receiver:	Sample pressure lower than anticipated; possible small leak on outlet valve found when leak checked. Brass cap was attached and tight.

Test Type (Units)	Method	Limits	Result	Pass/Fail
Ammonia (ppm)	D7941	< 0.1	< 0.004	Pass
Fixed Gases by FTIR				
Carbon Monoxide (ppm)	D7653	< 0.2	< 0.08	Pass
Carbon Dioxide (ppm)	D7653	< 2	< 0.05	Pass
Ammonia (ppm)	D7653	< 0.1	< 0.4	Pass
Methane (ppm)	D7653	< 100	< 0.2	Pass
Fixed Gases by GC/PDHID				
Argon (ppm)	D7833	< 100	< 25	Pass
Nitrogen (ppm)	D7833	< 100	< 25	Pass
Formaldehyde (ppm)	D7941	< 0.01	0.009	Pass
Hydrocarbons and other gases by GC/FID				
Total Hydrocarbons - Methane (ppm)	D7833	< 2	< 0.25	Pass
Carbon Dioxide (ppm)	D7833	< 2	< 0.5	Pass
Methane (ppm)	D7833	< 100	< 0.25	Pass
Total Halogenates by GC/MS				
Total Halogenated Compounds (ppm)	Default	< 0.05	0.001	Pass
Total Sulfur Compounds by GC/PFPD				
Total Sulfur (ppm)	Default	< 0.004	< 0.003	Pass
Water (ppm)	D7941	< 5	1.554	Pass

Signatures

Released By: John Mough

Released On: 10/25/2017 09:49

Timeline challenges

The \$55 million North Vineyard Grade Separation Project began February 24, 2014, with completion anticipated for mid-2016. When consulted by Ontario CNG Station, Inc., the City of Ontario's general contractor, the principal engineer, and Southern California Edison foresaw little interference with the proposed timeline of the hydrogen station project by the grade separation project. As it turned out, Southern California Edison was unable to install the utility connection required for the electrolyzer until after the grade separation project completed on March 18, 2016. The grade separation project also had a devastating effect on the day-to-day business operations of the existing Ontario CNG Station, Inc. gas station. The public works project caused station revenues to decrease almost 35 percent because one of the two entrances to the station were blocked for nine months.

On March 18, 2016, the Ontario mayor, City Council, public and private organizations, and members of the community officially dedicated the North Vineyard Grade Separation Project. Figure 11 shows the finished grade separation and underpass project.

Figure 11: Completed Grade Separation Underpass Project Viewed from Hydrogen Station Driveway



Source: Ontario CNG Station, Inc.

Environmental Impacts

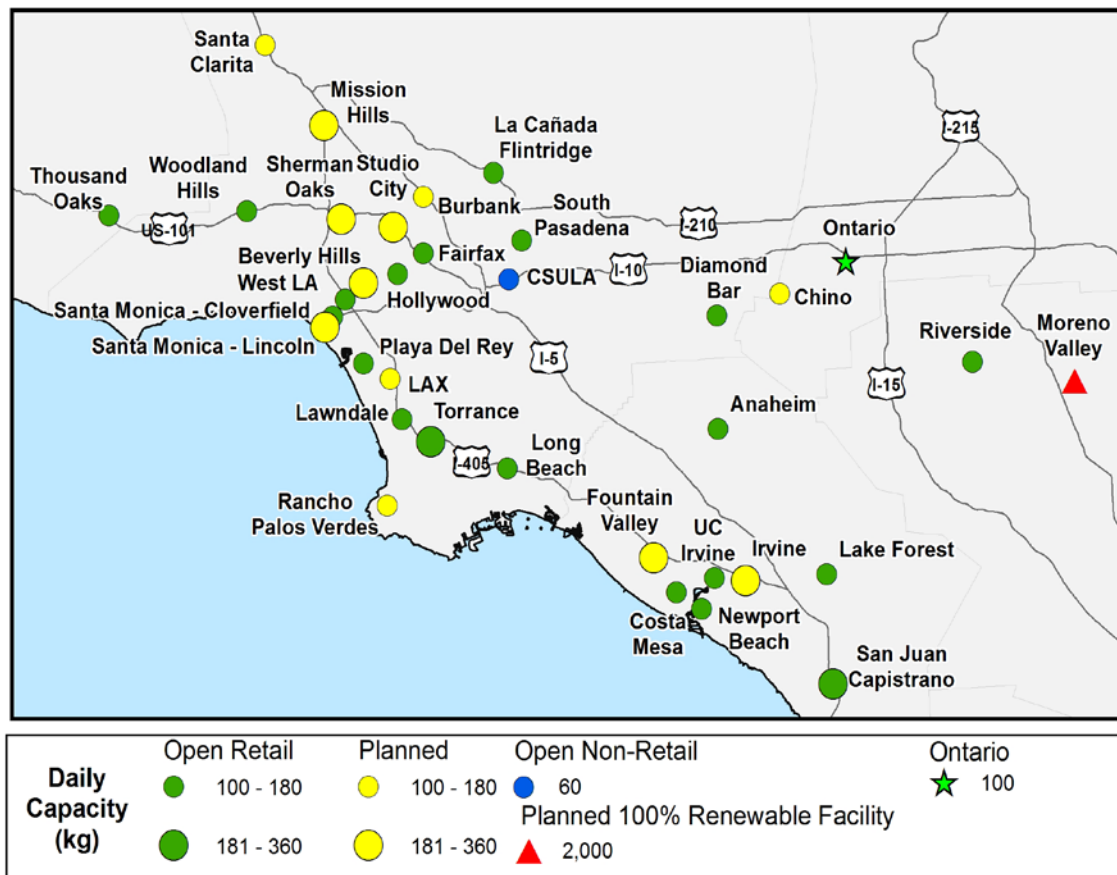
Hydrogen is stored onsite as a compressed gas in above-ground tanks concealed behind a wall at this station. The Ontario hydrogen refueling station sells 100 percent renewable hydrogen in accordance with the funding agreement with the Energy Commission. The hydrogen is produced from renewable sources including renewable electricity and biogas. The hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in case a leak occurs since hydrogen is nontoxic, colorless, and odorless. No solid waste will be produced at this site.

Plants and mature trees were planted in front of the hydrogen equipment for aesthetic purposes. The water that is rejected after the hydrogen and oxygen are separated by the electrolyzers used to irrigate of the landscape and to supply the on-site car wash.

Ontario Hydrogen Station in the Network

Figure 12 shows the Ontario Hydrogen Station, which is located adjacent to I-10 near Ontario International Airport, and four miles west of I-15, the gateway to the Inland Empire and Las Vegas.

Figure 12: Ontario Hydrogen Station



Source: California Energy Commission Staff

CHAPTER 2:

Energy Analysis and Data Collection

Up to 65 kilograms of renewable hydrogen will be generated by an on-site electrolyzer using renewable electricity, with additional renewable hydrogen delivered from a nearby source. The *Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model²* pathway for the hydrogen produced onsite is not certified, but will meet quality standards published under the Low Carbon Fuel Standard³ program regulated by California Air Resources Board.

The electrolysis unit uses electricity that is linked to renewable energy credits that are traced through the Western Renewable Energy Generation Information System⁴. Electricity is purchased from Southern California Edison and the renewable energy credits are purchased from an energy broker, 3-Phase Renewable, who routinely provides such credits to California companies.

Data on the operation of the station will be collected and reported to the Energy Commission throughout the three-year term (3/1/2018 to 2/28/2021) of the operation and maintenance grant. Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the actual performance of the project to proposed expectations.

² GREET® Model <https://greet.es.anl.gov/>.

³ <https://www.arb.ca.gov/fuels/lcfs/lcfs.htm>.

⁴ <https://www.wecc.biz/WREGIS/Pages/default.aspx>.

CHAPTER 3:

Conclusions

The owners of the Ontario hydrogen station planned to provide clean, alternative fuels at the station when the property was purchased in August 2008. Ontario CNG Station, Inc. plans to continuously operate the station to provide hydrogen refueling for the foreseeable future as a part of the array of existing alternative fuel options offered at the station. The substantial amount of capital investment required to build the station will require many years of operation to recoup.

The Ontario station is located within the jurisdiction of the City of Ontario, making the zoning process more accessible than larger jurisdictions like the City of Los Angeles. The North Vineyard Grade Separation Project delayed Southern California Edison from completing the final power connection for the hydrogen station. After Southern California Edison completed the electrical system connection, the City Building Department required additional station work before issuing an operating permit. This series of events added approximately \$25,000 to the final station cost. The Ontario station was completed on April 24, 2018.

Acronyms

Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)

California Energy Commission (Energy Commission)

Division of Measurement Standards (DMS)

Fuel Cell Electric Vehicle (FCEV)

Governor's Office of Business and Economic Development (GO-Biz)

National Fire Protection Association (NFPA)

Program Opportunity Notice (PON)